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Title: The DOE Radiological Triage Program

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The DOE Radiological Triage Program

Pete Karpius

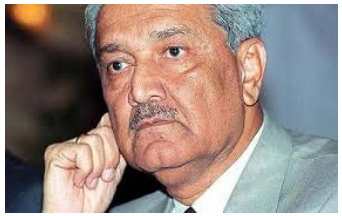
LANL PADOPs Briefing 2017

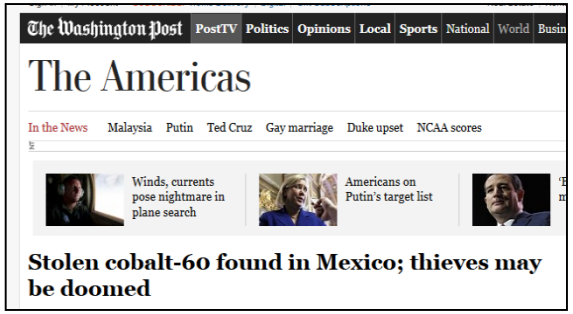
Motivation

- The first line of defense in the nuclear emergency response mission often involves analysis of data provided to the NNSA's **Radiological Triage System*** by personnel in the field.

- **The Three Questions Triage Must Answer**:
  - Threat / No threat ?
  - What exactly is it?
  - How much is present?

A Customs and Border Protection officer inspects a container with a handheld radiation detector. (U.S. Customs & Border Protection)



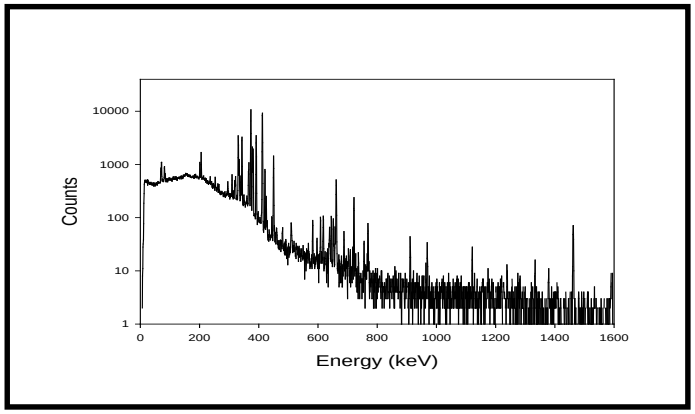


* http://nnsa.energy.gov/aboutus/ourprograms/emergencyoperationscounterterrorism/respondingtoemergencies/rendersafe-2

Origins of Triage

- Jan 2002: Toy soldiers were smuggled into USA from Mexico; some contained a small amount of uranium powder.
- Early results misinterpreted as highly-enriched uranium.
- National Lab analyses indicated depleted uranium
- A clear need for a program based on expert analysis of such events was manifested

What Triage Provides



24/7 support to emergency response teams who send data for analysis.

- **Specialize in interpretation of spectra from portable radioisotope identifiers.**
- **Online within 10 minutes, usually provide an answer in 30-60 minutes.**

Identification of threats and illicit materials, minimize the cost of a false/innocent alarm.

Provides immediate, remote, electronic access for peer-reviewed data analysis

Sandia National Laboratories

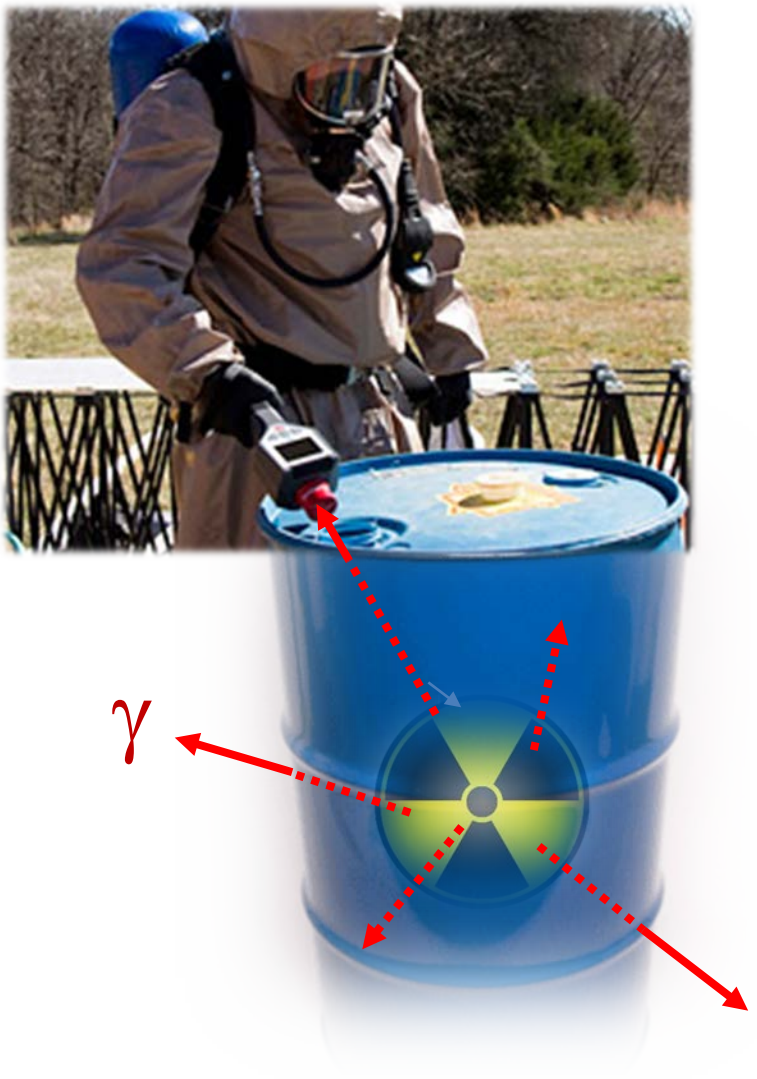
Los Alamos

Lawrence Livermore National Laboratory

Who does Triage Support?

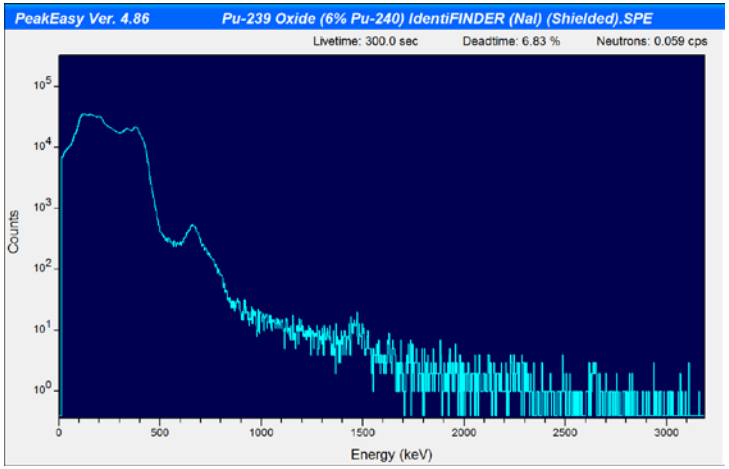
Local, State, and Federal agencies both domestic and foreign

Data from the Field



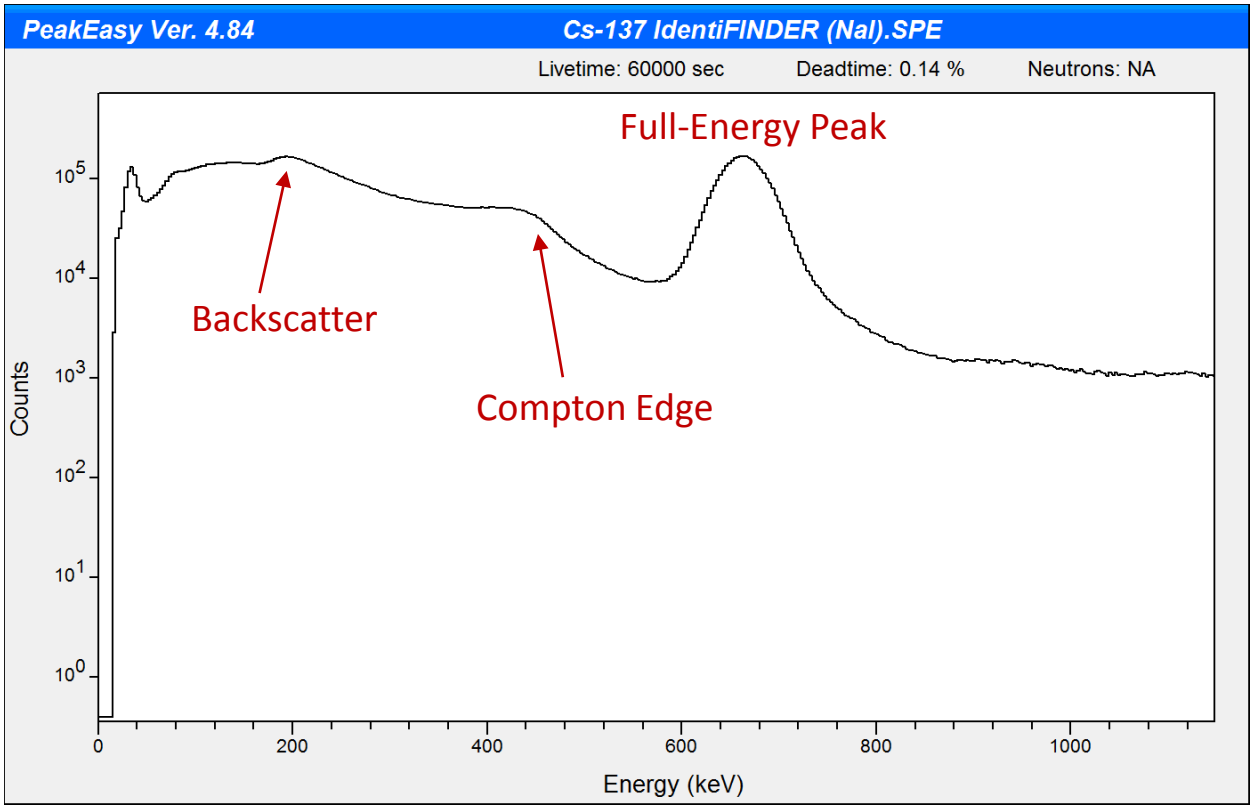
Gamma rays from a radioactive source deposit energy in the surrounding environment including this responder's radiation detector.

The different energies and intensities of these photons at each energy gives rise to a unique **"gamma-ray spectrum"**.



What exactly is a spectrum?

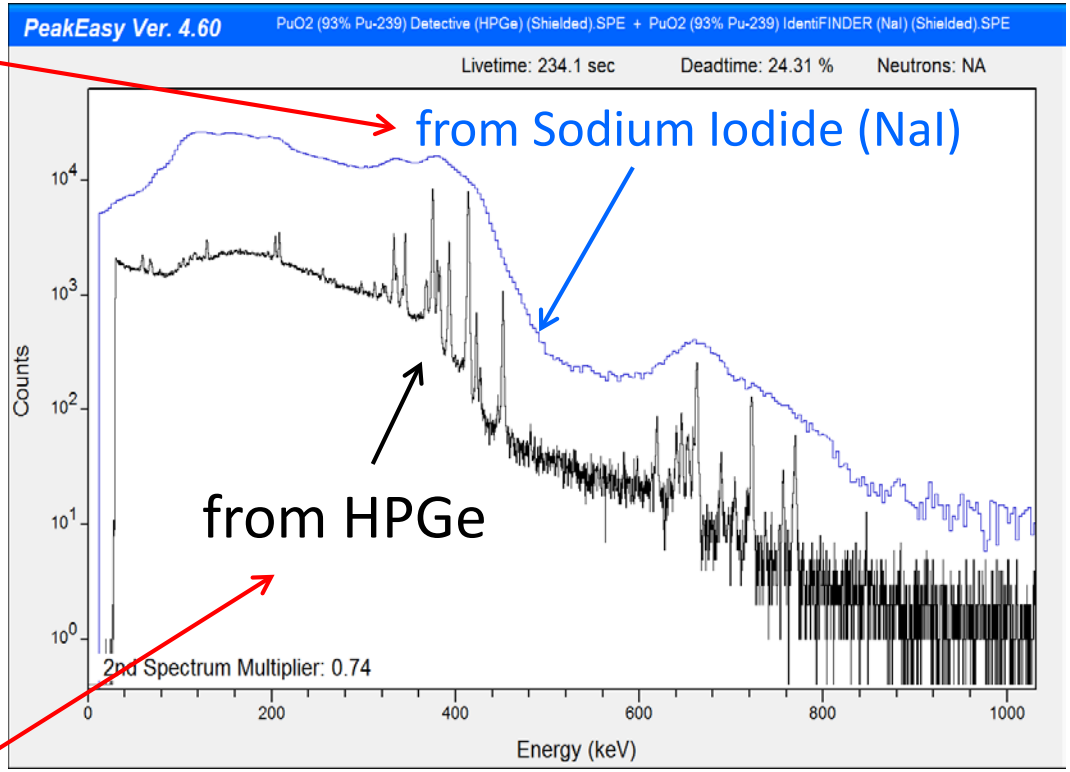
A gamma-ray spectrum is just a *histogram* of counts versus energy deposited in the detector.

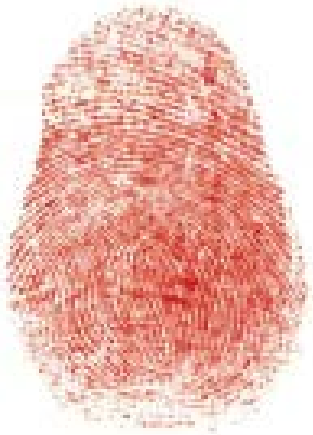


Triage analyzes gamma-ray spectra to determine nuclide identification and possibly bound the amount of radioactive material.

A Spectrum is a ‘Fingerprint’

Two gamma-ray spectra of the same Pu item





Each radionuclide has a unique gamma-ray signature that can be used for identification. That is why we call a spectrum a fingerprint.

Section 2: Threat / No Threat?

Weapons-Usable Material & Signatures

Pu: Neutrons and many strong gamma rays, hard to shield. Can use weapons-grade or reactor-grade.

Am-241: Contaminant in Pu, sometimes easier to see. Also common in commercial applications.

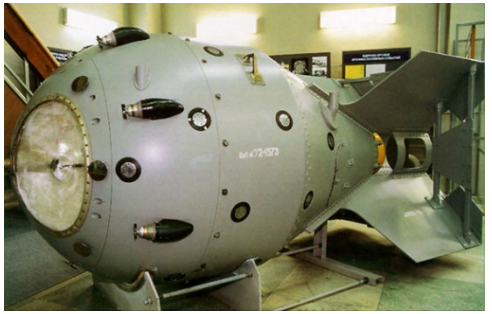
Enriched U (U-235) a few weak gamma rays, easily shielded.

Depleted U (U-238) strong gamma rays, hard to shield. Some weapons applications, and also common in commercial products.

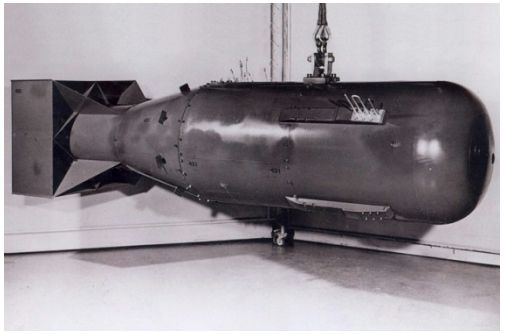
U-232: A common contaminant in USA and Russian enriched uranium. Easily seen if present. Can be confused with natural thorium.

U-233: Rare, no visible signal but U-232 contaminant is always present.

Np-237: Rare, but "can be used for a nuclear explosive device". Many strong gamma rays, hard to shield.



"Joe 1"



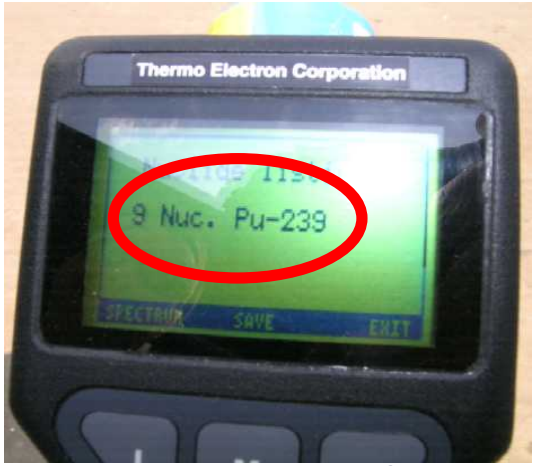
"Little Boy"

Np-237

Plutonium at the Dump?

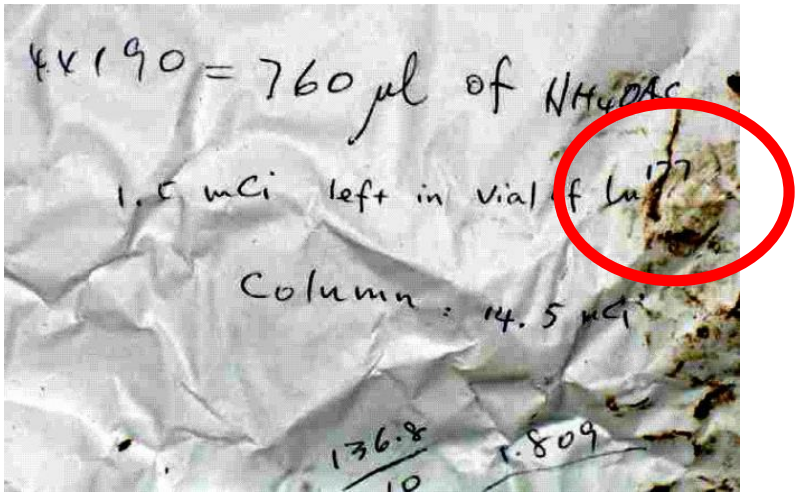
- **Radiation detectors alarmed when a dump truck entered a landfill. Initial identification is Pu-239.**

- **Medical waste found, including a note indicating Lu-177.**



automatic identification

medical waste



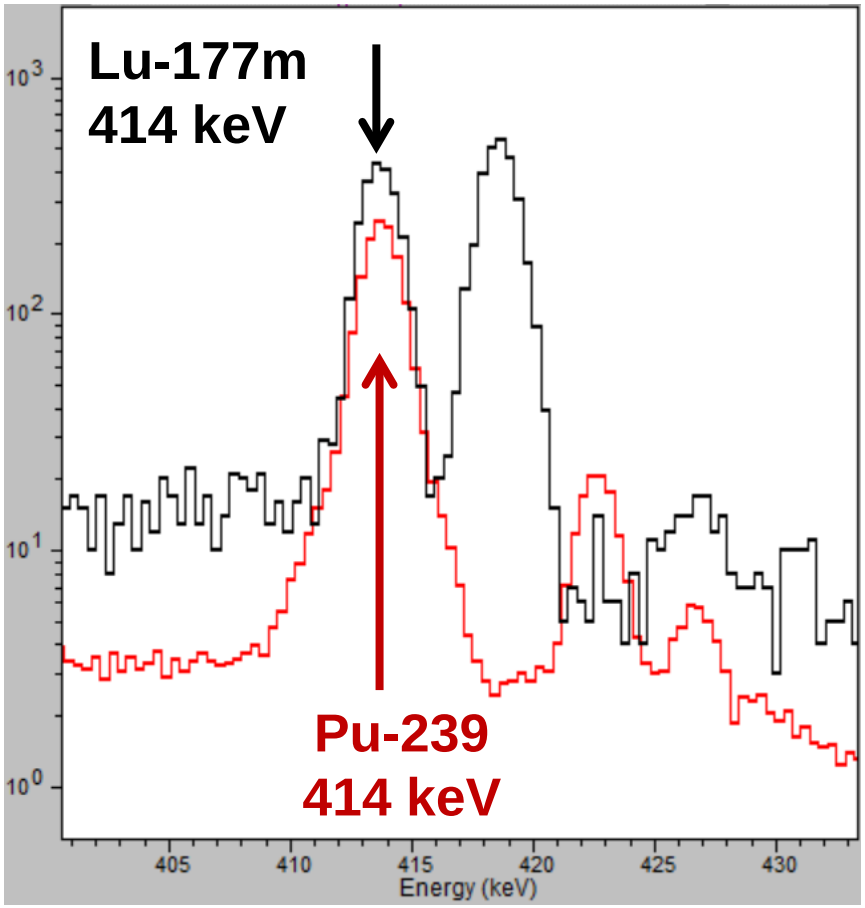
note suggesting Lu-177

Plutonium at the Dump (cont.)

^{177m}Lu was the culprit.

^{177m}Lu is a contaminant in the radiopharmaceutical ^{177}Lu

(Half lives: Lu-177 = 6.7 days, Lu-177m = 161 days)



Old Lu-177
(HPGe Detail)

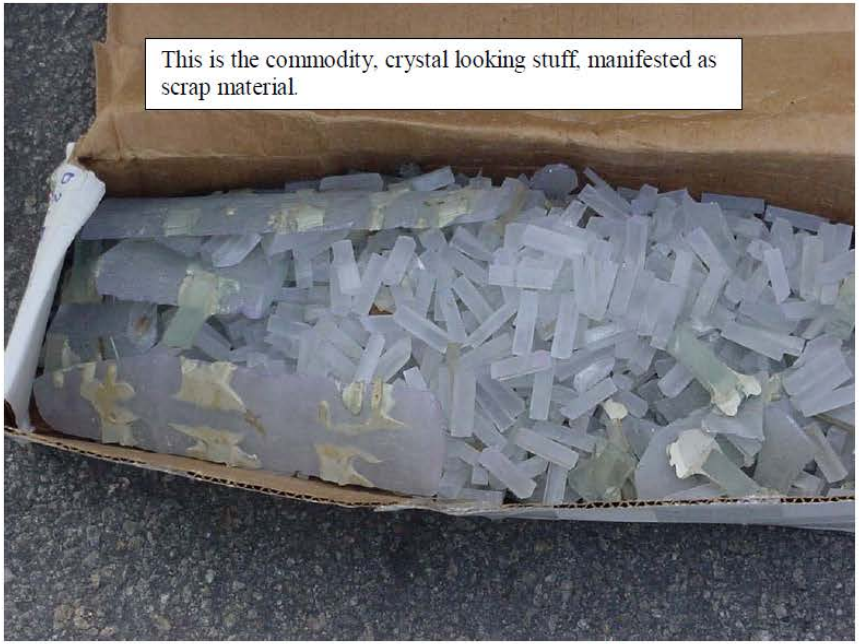
Np & Pu from China?

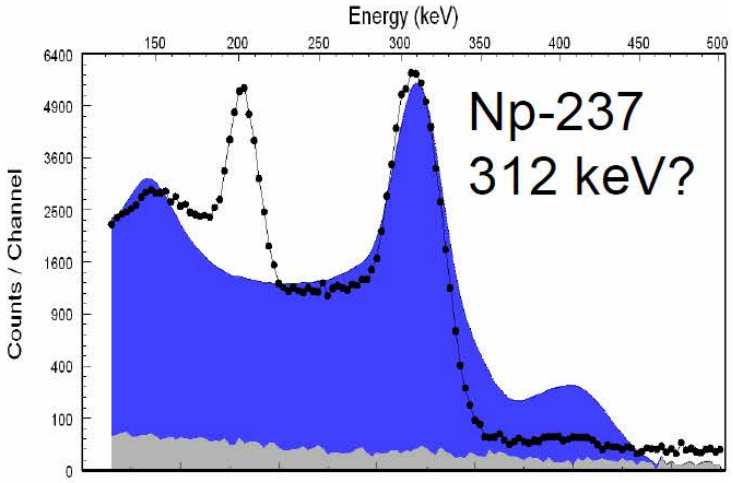
Shipment seized by U.S. Customs on suspicion of smuggled special nuclear material.

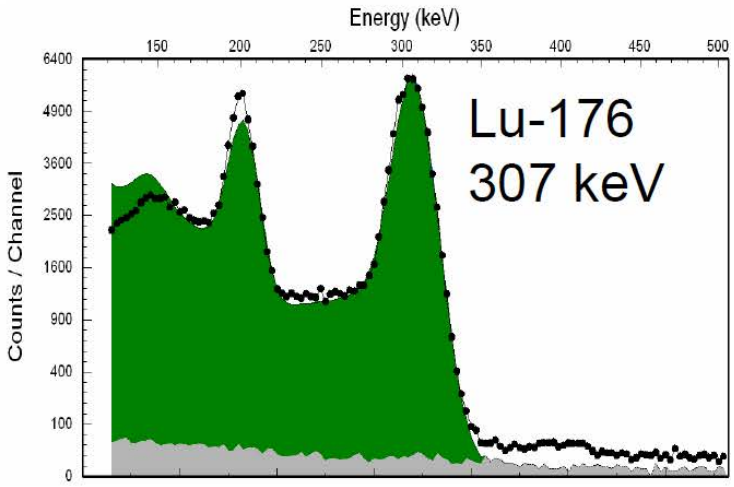
Submission email:
“Per our conversation, see GR-135 file for analysis. In addition to the neptunium-237 we are getting a plutonium-239.(See attached file)”

Np & Pu from China?: Lu-176

- **Radioactive boxes contain glass.**
- **GR-135 reports Np-237 & Pu-239.**
- **Triage identifies Lu-176, no Np, no Pu, no threat.**







FOXNEWS.COM HOME > WORLD *Thursday, November 29, 2007*

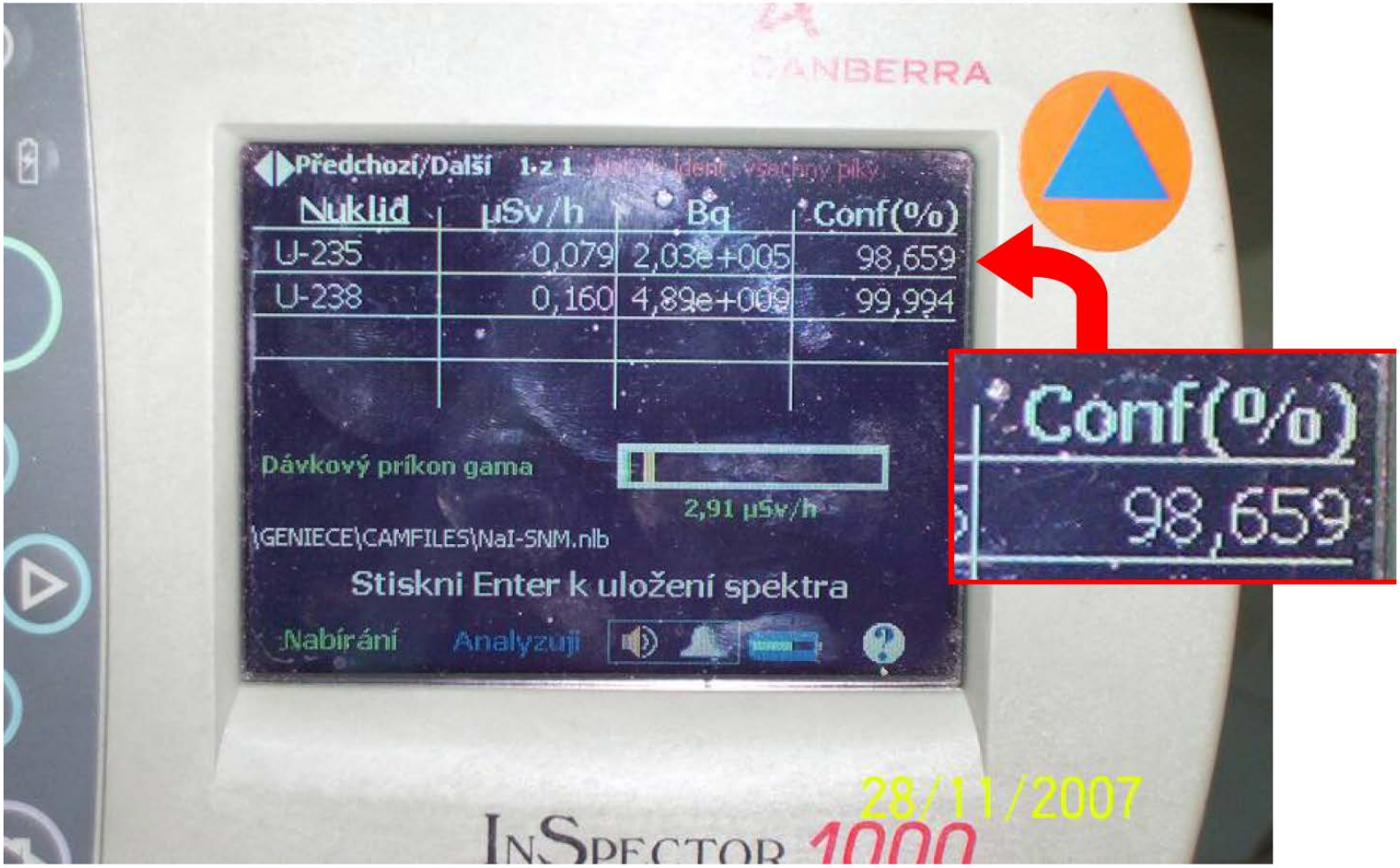
Slovak Police: Seized Uranium Enriched Enough to Make 'Dirty Bomb'

BRATISLAVA, Slovakia — "Two Hungarians and a Ukrainian were arrested in an attempted sale of uranium believed to be from the former Soviet Union…

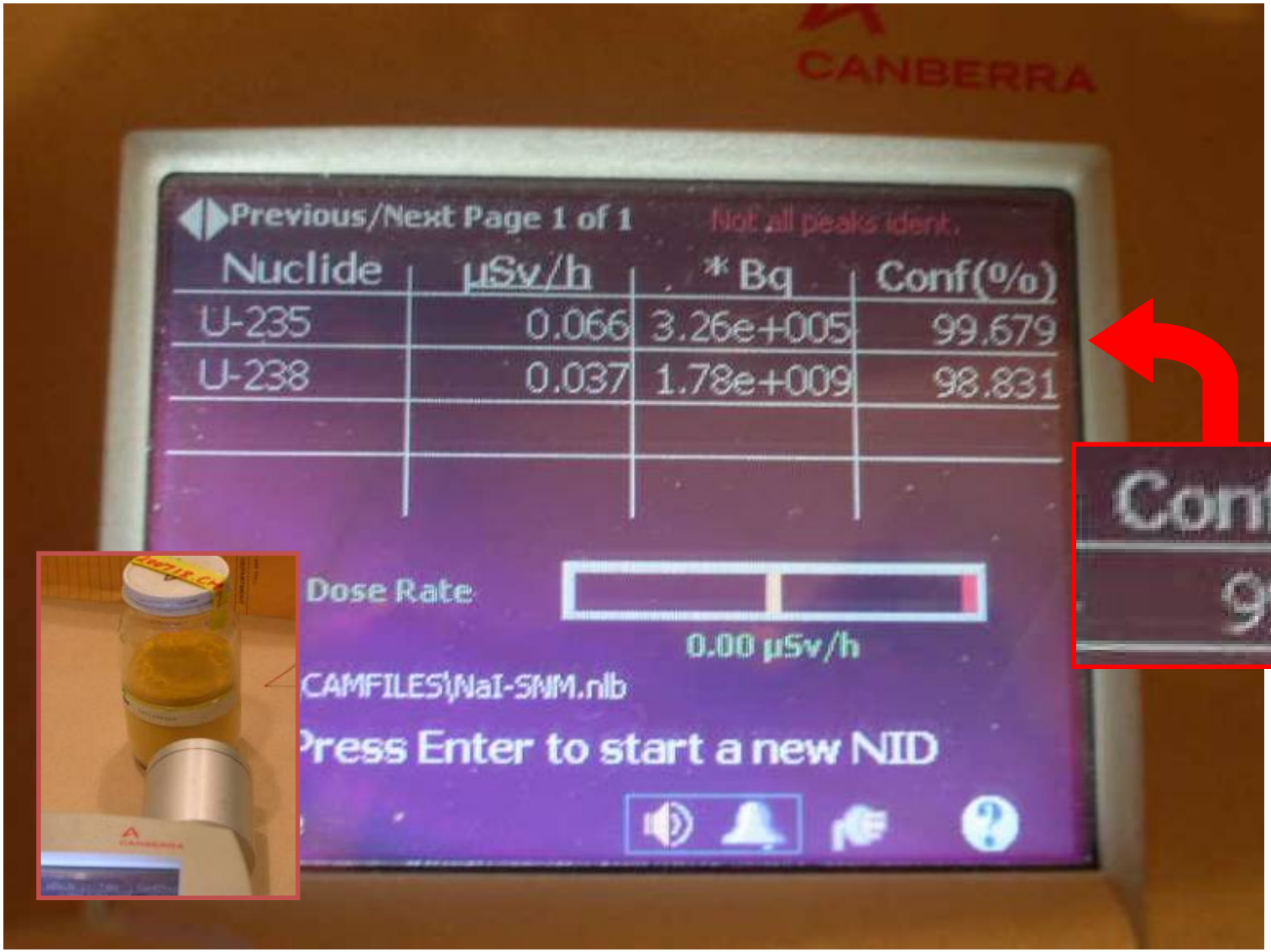
…allegedly selling for 1 million $US"

Confidence is High = Enrichment is High?

"Investigators determined that it contained 98.6 percent U-235."
Inspector-1000 image on website may have caused confusion.



Replicating the Field Measurements in the Lab



Informing the Public

Informing the Public

Informing the Public

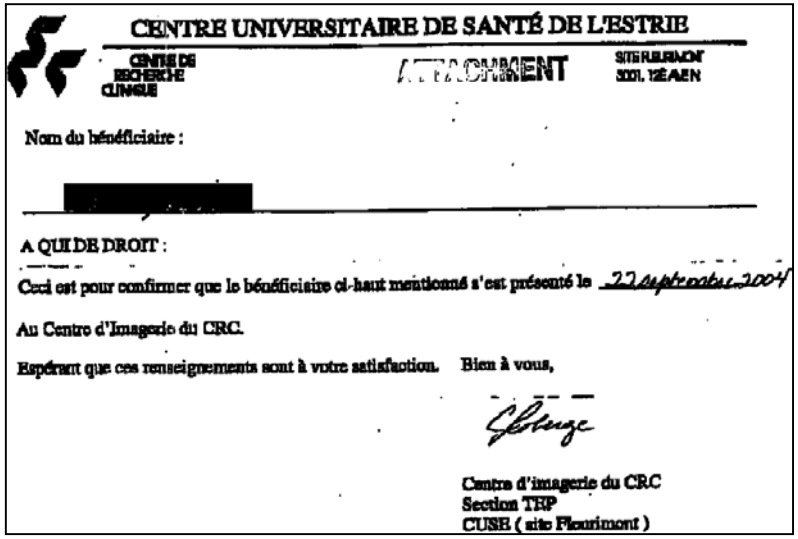
Section 3: Medicals & Industrials

Common Medical Isotopes

Tc-99m	Many imaging uses
Tl-201	Heart imaging
I-131	Thyroid treatment
F-18	PET imaging
I-125/Pd-103	Prostate cancer
Sr-89/Sm-153	Bone cancer
Ga-67	Soft-tissue imaging
Y-90	Liver cancer, leukemia

& dozens of others

- **Many patients do not know which isotope they have received.**
- **Some patients are very surprised to learn that they are radioactive.**
- **Doctors are learning to provide better documentation.**



CENTRE UNIVERSITAIRE DE SANTÉ DE L'ESTRIE

CENTRE DE RECHERCHE CLINIQUE

ATTACHMENT

SITE FLEURIMONT
3001, 12E AVEN

Nom du bénéficiaire :

[redacted]

A QUI DE DROIT :

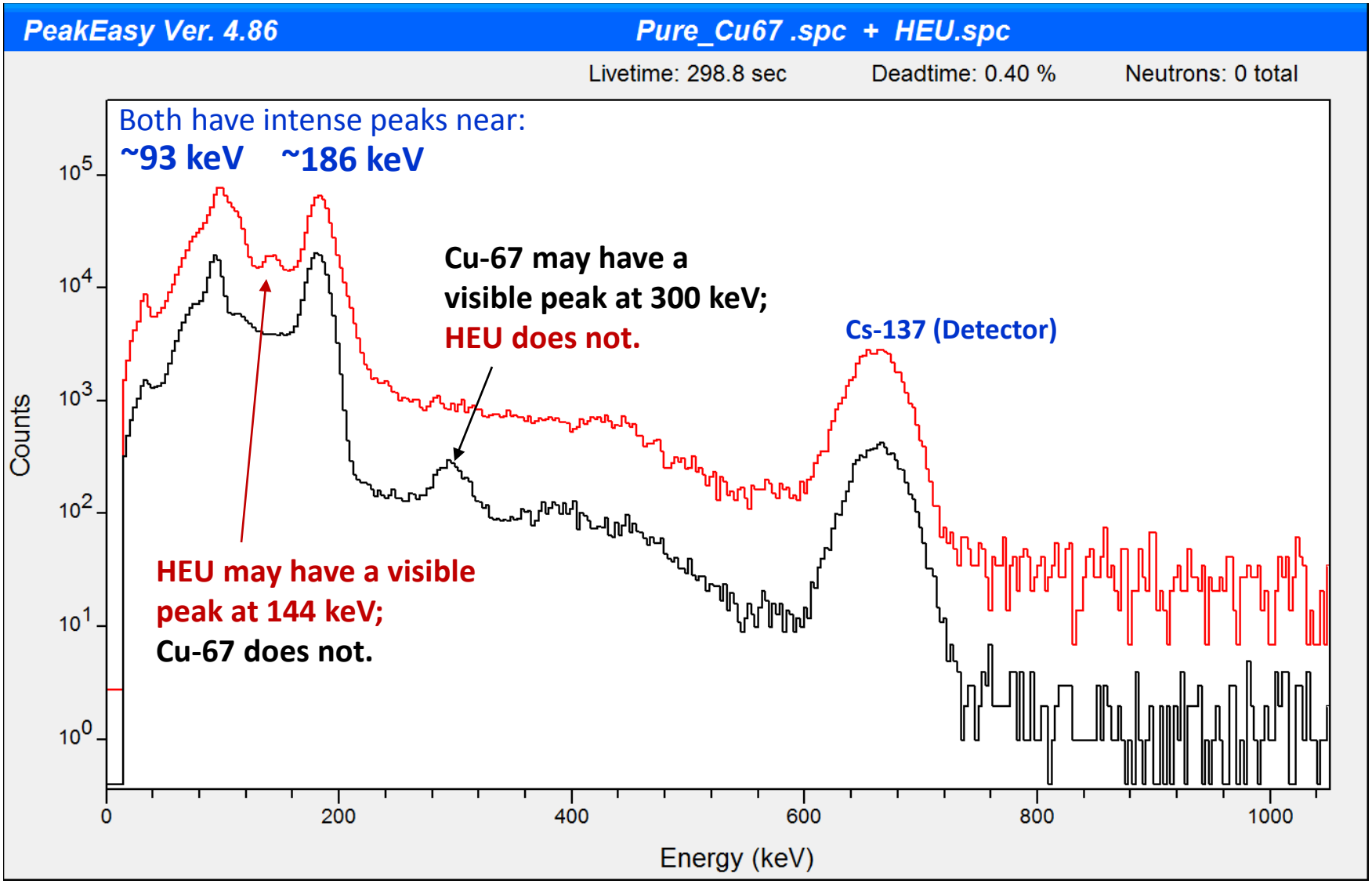
Ceci est pour confirmer que le bénéficiaire ci-haut mentionné s'est présenté le 22 septembre 2004

Au Centre d'Imagerie du CRC.

Espérant que ces renseignements sont à votre satisfaction. Bien à vous,

Centre d'imagerie du CRC
Section THP
CUSH (site Fleurimont)

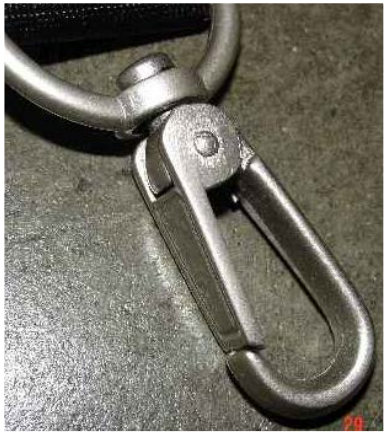
Compare Cu-67 (black) to HEU (Red) in low resolution



Co-60 in Recycled Metal

200 contaminated metal tissue boxes were distributed across the United States. Contact dose is up to 21 mRem/hr.

Luggage fasteners

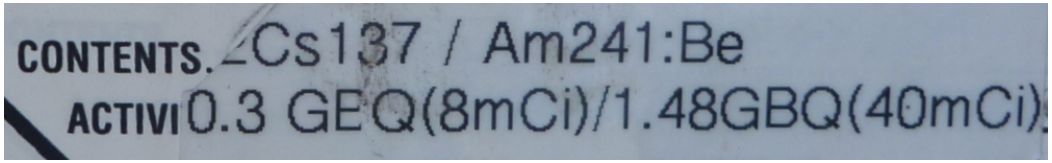


Access covers

petco

Troxler Gauge Abandoned in Tucson

IPC left on ground next to dumpster in parking lot of
City Council Ward 5 office, about 50 yards from a police station.



Co-60 South of the Border

Gas station in Tepojaco, Mexico where the theft occurred Monday. Driver was sleeping in his truck. Two men with a gun forced him out of the truck and tied him up. Truck was found 25 miles away on Wed.

Theratron 780 teletherapy head. The Co-60 had been removed from its container and was found in a "rural area" 1 km away.

Co-60 South of the Border

Six men ages 16 to 38 were detained Thursday as part of the investigation and taken to a hospital in Pachuca for testing.

Only the 16-year-old showed signs of radiation exposure and he is reported to be was in good health.

IAEA said the cobalt has an activity of 3,000 Ci

Feet	R/hr
1	39,000
2	9750
3	4300
6	1100

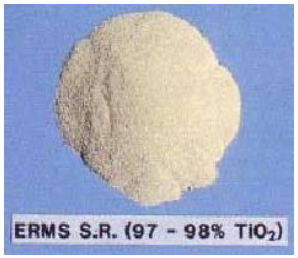
LD_{50} is about 500 R (bone marrow death)

→ about 1 minute at 1 ft for Co-60, 2600 Ci, unshielded.

Thorium is Common

Aircraft Turbines

Lantern Mantles



Rutile

Optics

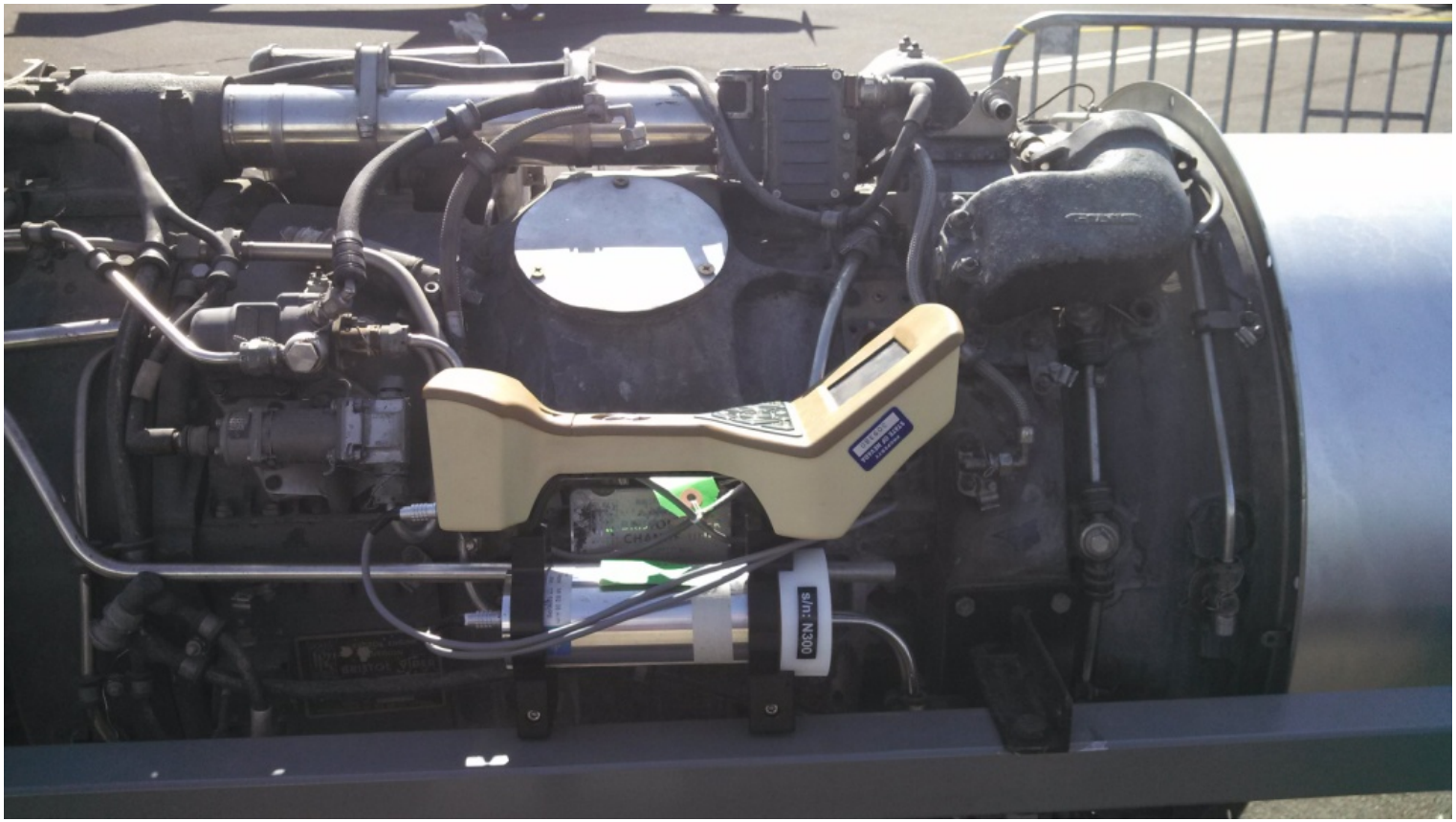
Kitty Litter (also contains U-238 daughters, K-40)

Welding Rods

Th-232 in Jet Engine

14 Sep 2013 Reno, Nevada

Jet engine on display at the National Championship Air Races



Uranium is Common

Item found in landfill

Wire found in laboratory

U_3O_8 (Yellowcake)

Scrap metal (DU)

Decorative Glass

Radium is Common

Dinosaur Bone
(also with Uranium)

Brachytherapy source
(abandoned)

Radioluminescent Dial

Ra-226 is present in fossil fuels. Rn-222 is enhanced in propane refining.

Neutron Sources…Less Common

Honduras

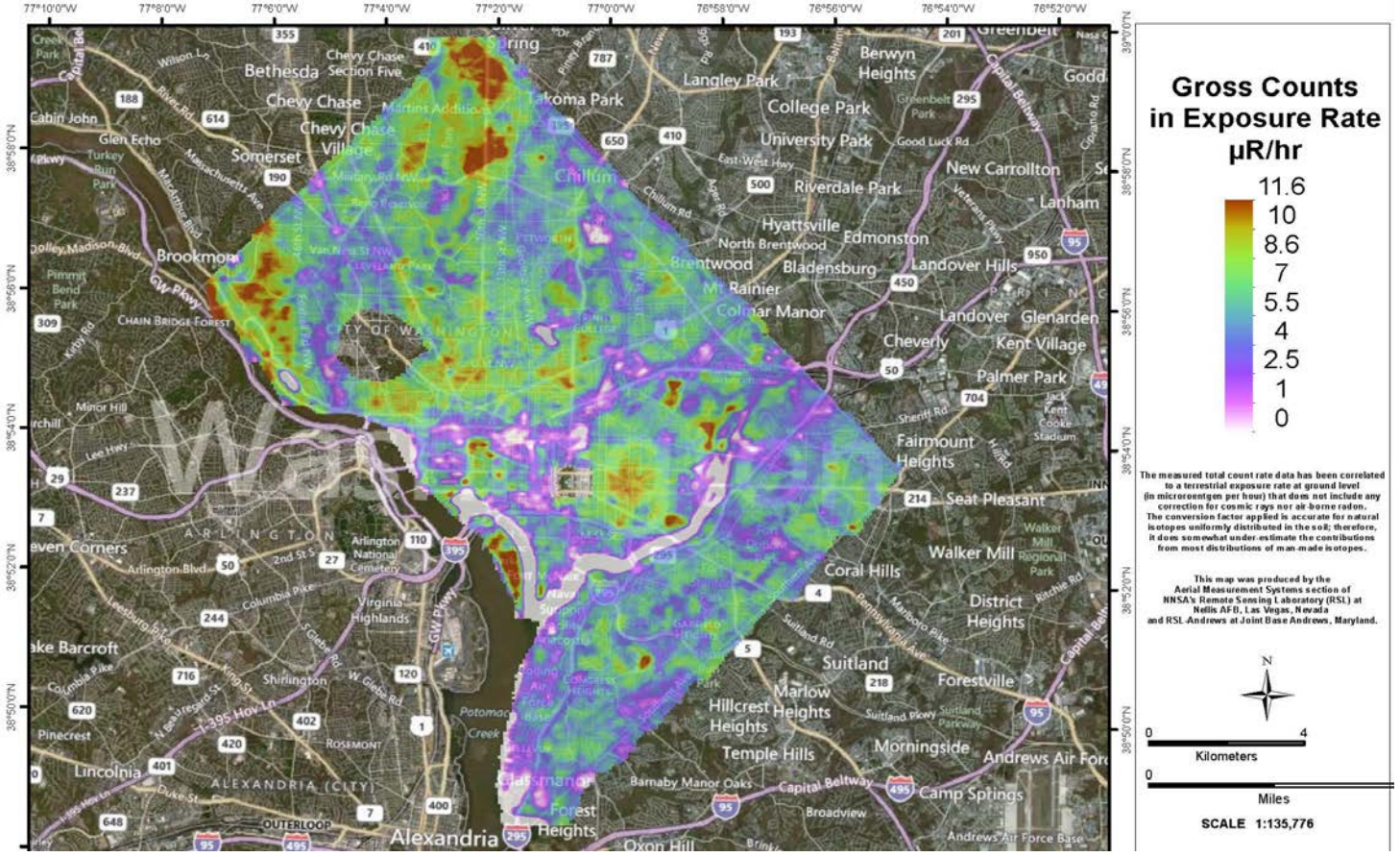
Sri Lanka / India

Canada / USA

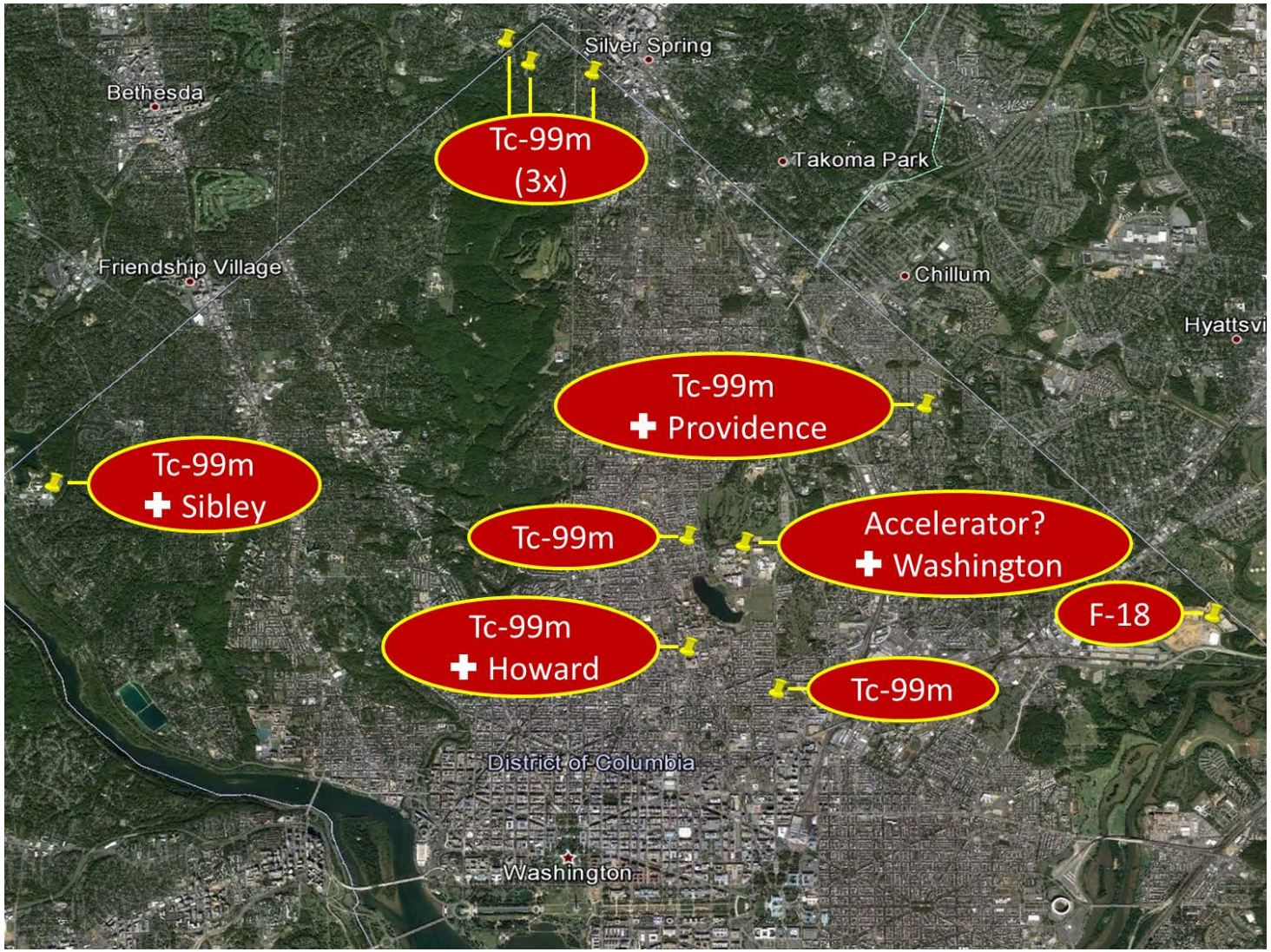
Mexico

Section 4: Recon

Pre-Inauguration Aerial Surveys of DC



DC Aerial Survey Hits

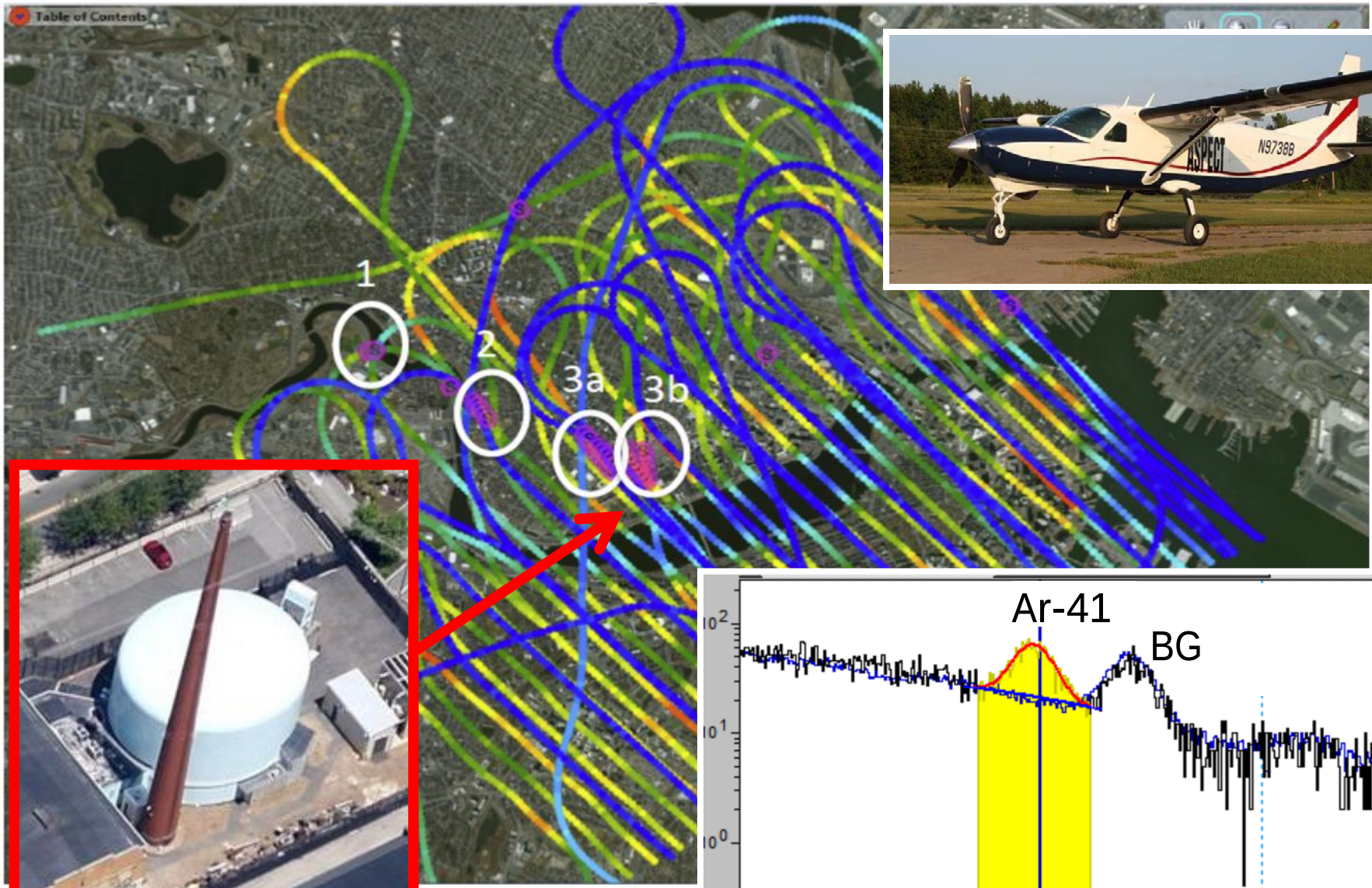


Pre-Boston Marathon Aerial Survey

- **An EPA *ASPECT* aircraft with RSI low-resolution gamma system surveyed Cambridge before the Boston Marathon**
- **The survey area included the MIT Research Reactor II, and two licensed facilities with Co-60 sources**
- **Four hits resolved as Ar-41 and Co-60 by EPA were examined by DOE**

Multiple Hot Spots, Boston Flyover

Determined to be a plume of Ar-41 vented from a research reactor



Ar-41 is a Common Research Reactor Effluent

Air is 0.9% ^{40}Ar (stable)
$^{40}Ar + n \rightarrow {}^{41}Ar$ ($t_{1/2}$ = 1.8 h)
$^{41}Ar \rightarrow \beta^- + {}^{41}K + \gamma$ (1294 keV)

- **Air in the experimental ports and graphite reflector region is exposed to neutrons**
- **Ventilation and release is necessary to reduce ^{41}Ar internal buildup**
- **Increasing ^{4}He purging can reduce production overall, but is expensive**

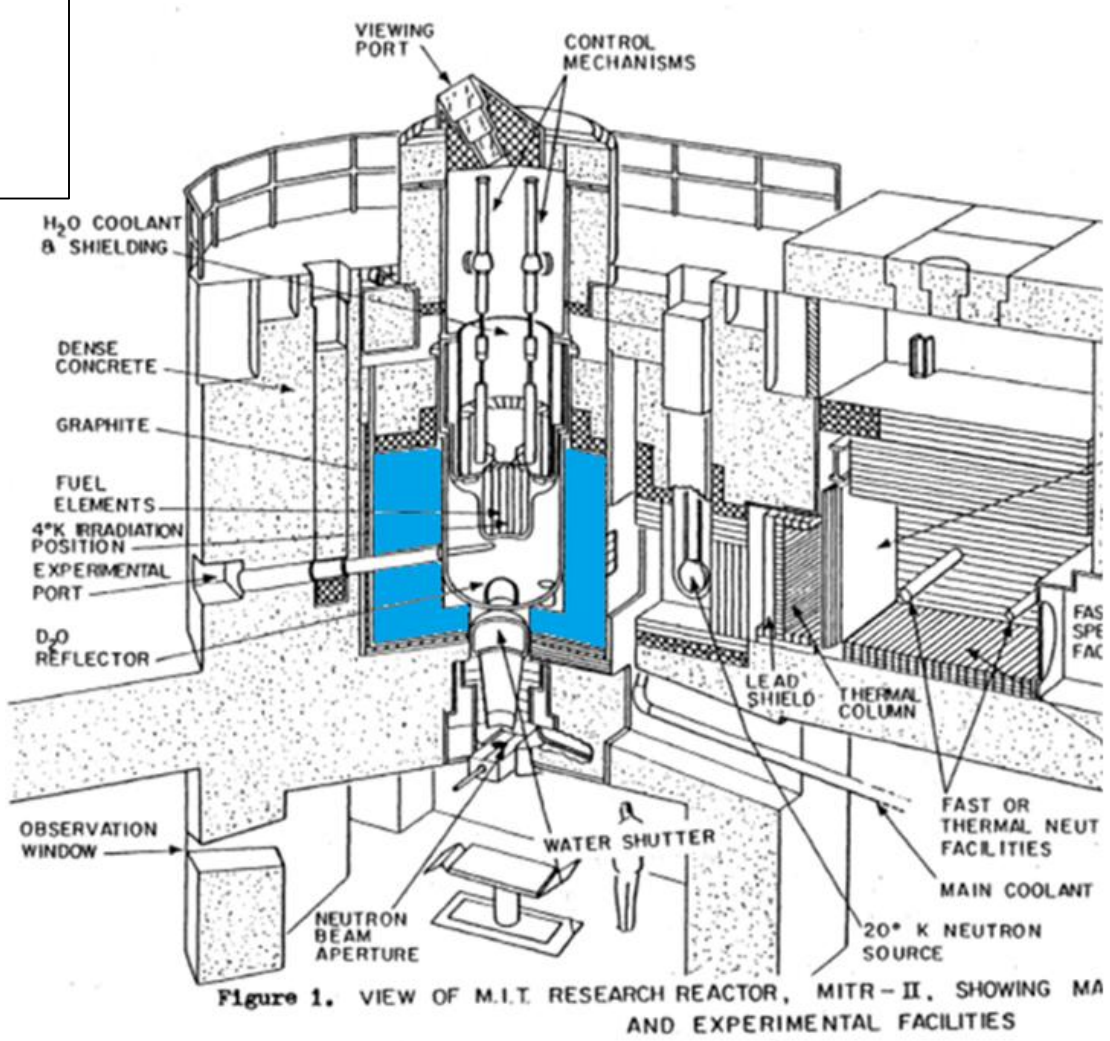


Figure 1. VIEW OF M.I.T. RESEARCH REACTOR, MITR-II, SHOWING MA
AND EXPERIMENTAL FACILITIES

Section 5: Collectors and Hoaxes

Albuquerque Collector

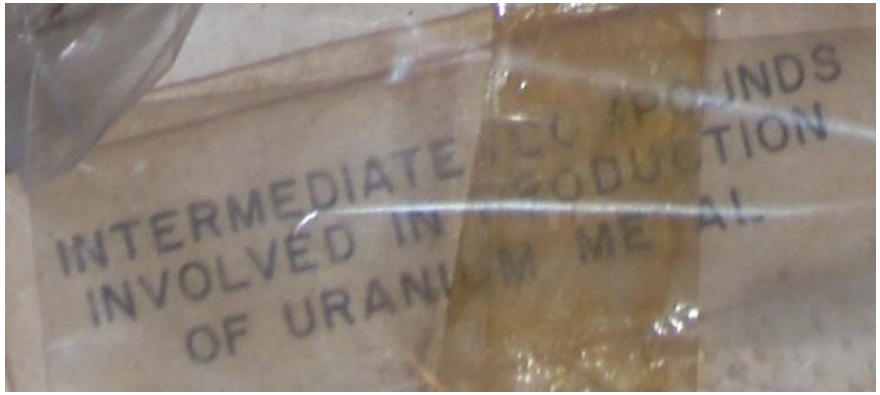
Indianapolis Collector

FBI visits a house in Indianapolis, collects data on a uranium sample. Resident also claimed to have Pu (but none found).

Ronkonkoma Collector

Excerpt From Suffolk County PD submission:
Papers found listing:
"**German Uranium metal captured by General Patton's Troops during the invasion of Germany in 1945**"
"**Pure Uranium metal**"

Ronkonkoma Photo Details



Carnotite: a bright to greenish yellow mineral that occurs typically as crusts and flakes in sandstones. The high uranium content makes carnotite an important uranium ore.

Plutonium?


CAUTION
DANGEROUS
RADIO ACTIVE
PLUTONIUM


“pultoniyum”
Chernovil Nuclear
Energy Station

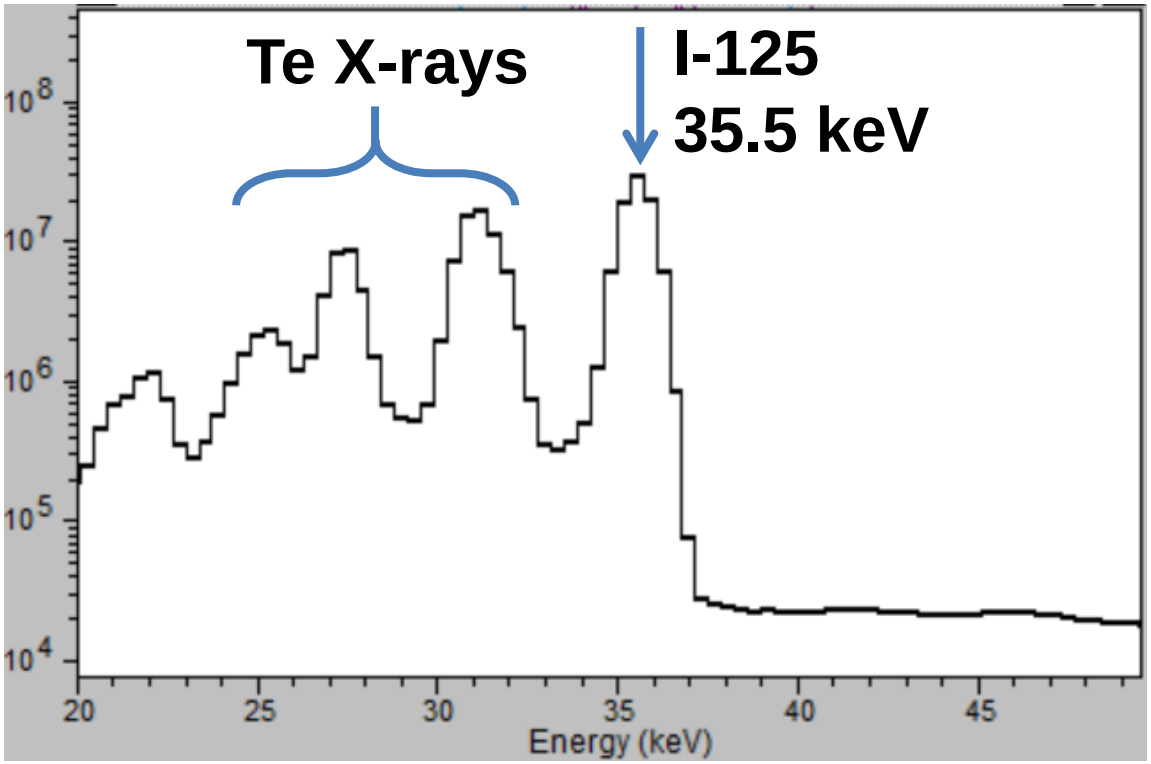
Section 6: Miscellaneous

Radioactive Dice

“Hoo Hey How” Dice

Homemade Detector

Gambling tools tagged with radio-isotopes have been interdicted on several occasions.



HPGe spectrum of dice (detail)

More Radioactive Dice

Dice with Am-241?

I-125 smuggled in Pringles can

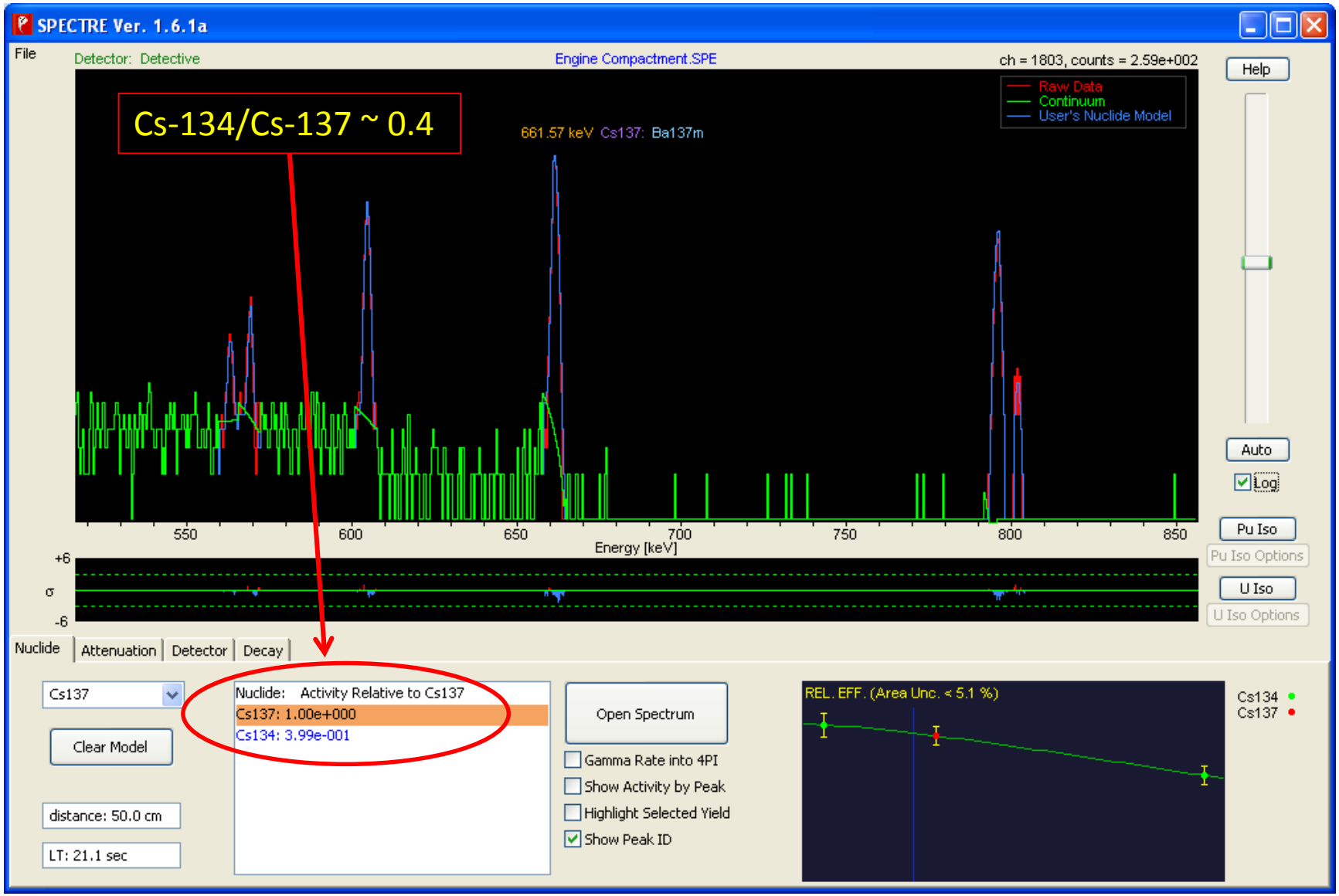
I-125 smuggled in coffee

Capsule for smuggling Sr-90

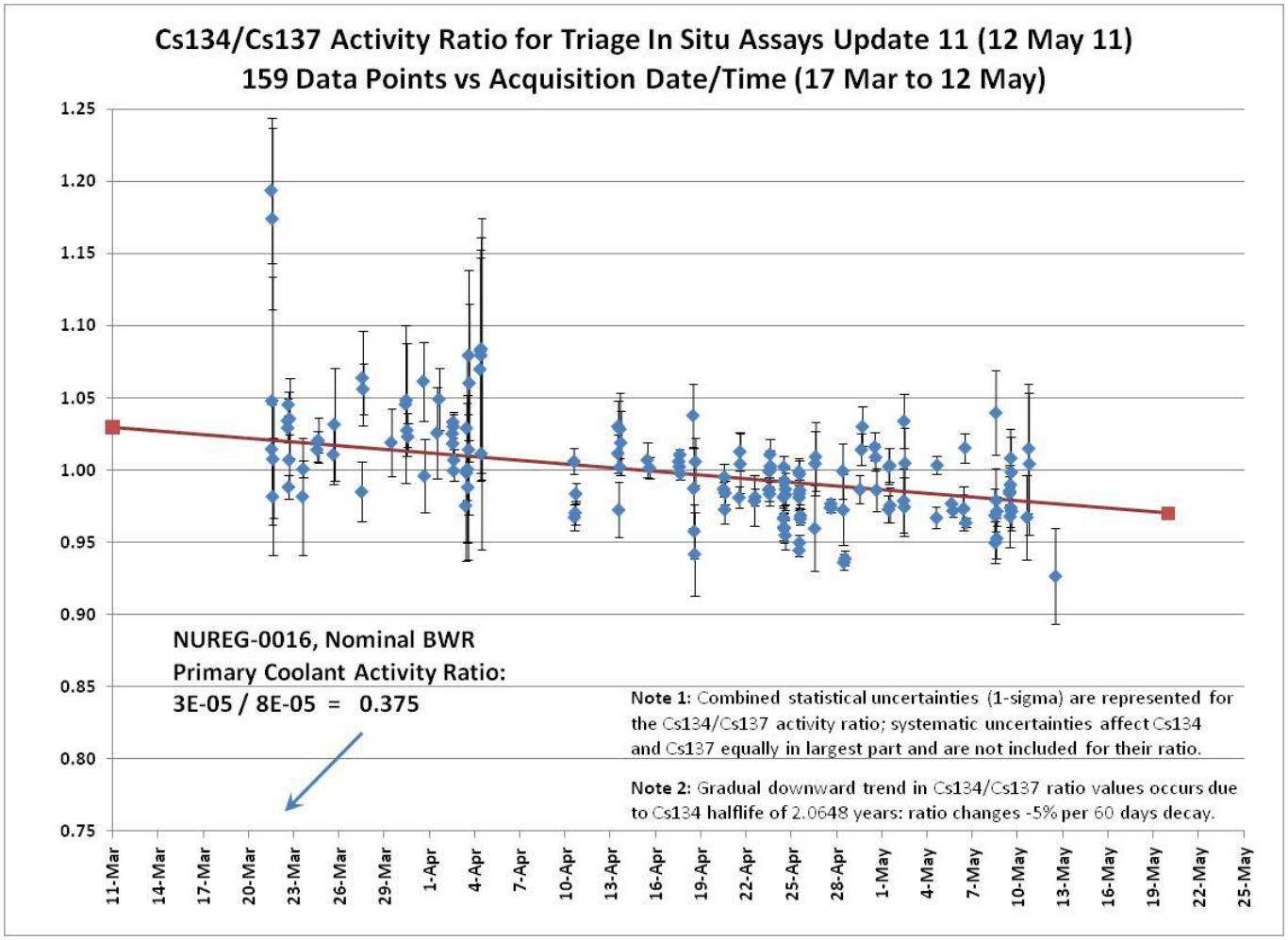
Radioactive Car in Mombasa

- Event submitted by Kenya Radiation Protection Board (KRPB)
  - POC for SLD in country made submission via email
  - Surveying cars imported from Japan
  - One vehicle exhibited count rates outside their normal limits
  - ORTEC Detective spectra were recorded and Cs-137 was reported for various parts of the car.
    - Engine compartment
    - Boot
    - Driver's Seat

Engine (and Boot) Cs137:Cs134



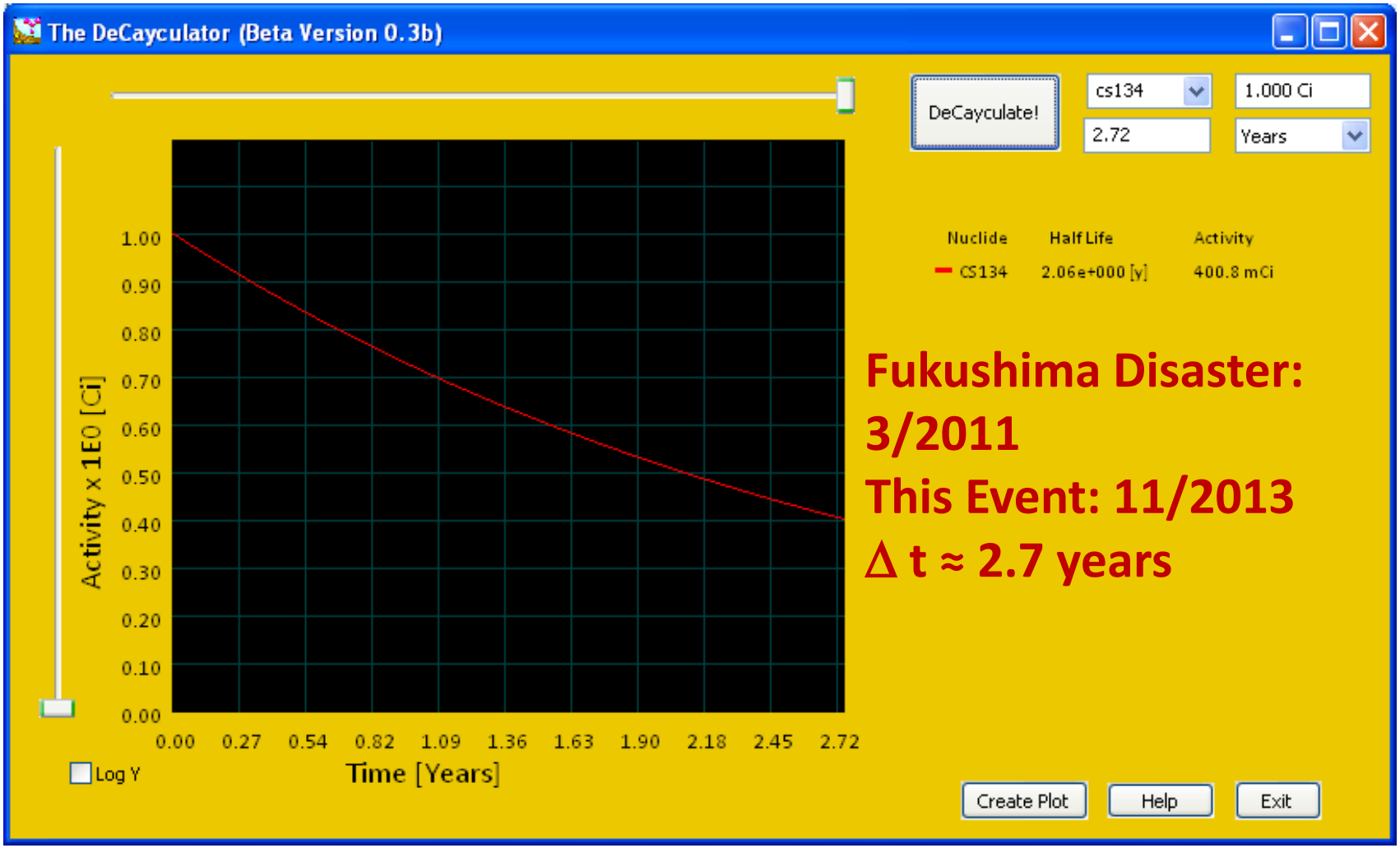
Cs-134/Cs-137≈1 @ the time of Fukushima



DOC # LLNL-PRES-495432 N. Wimer et al.

Decay of Cs-134

How long does it take Cs-134 to get to 0.4 of its initial activity?



Fukushima Disaster: 3/2011

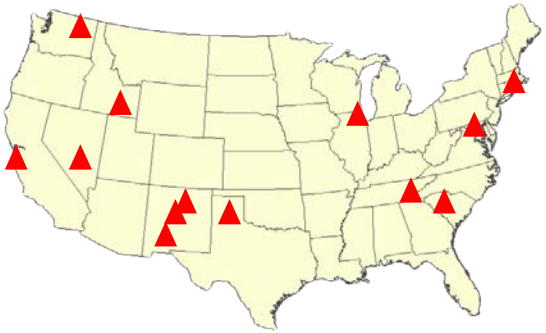
This Event: 11/2013

$\Delta t \approx 2.7$ years

What if the data do represent a threat?

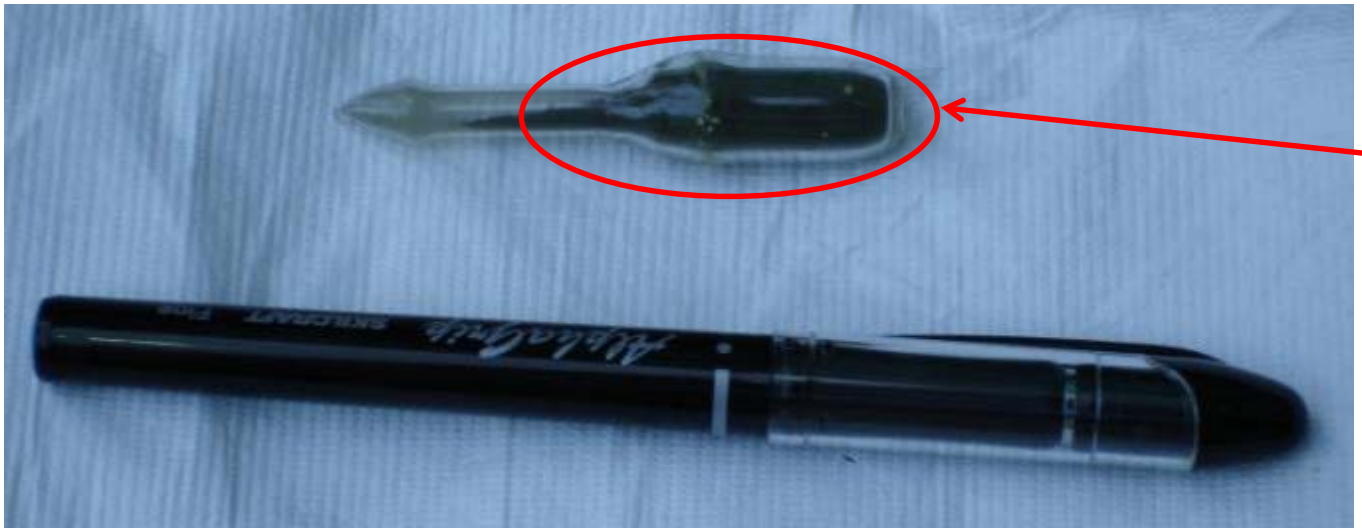
Office of Emergency Response

- Provides technical support for:
  - Nuclear or Radiological Accidents
  - Lost / Stolen / Abandoned Radiological Materials
  - Nuclear Terrorism Events
    - Improvised Nuclear Device (IND)
    - Stolen Stockpile Weapon
  - Radiological Dispersal Device (RDD)



- Deployable capabilities configured for a rapid response
  - DOE teams support DOJ and DOD responders

Tip of the Iceberg?



Glass vial with black powder

Pb

Wax